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International Economic Analysis and Prospects

International Economics Department
The World Bank
September 1993
WPS 1187

How Should Sovereign Debtors Restructure Their Debts?

Fixed Interest Rates, Flexible Interest Rates, or Inflation-indexed

Andrew Warner

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This paper — a product of the International Economic Analysis and Prospects Division, International Economics Department — is part of a larger effort in the department to understand the links between the international economic environment and the growth process in developing countries. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Jacquelyn Queen, room S8-216, extension 33740 (September 1993, 35 pages).

Can developing countries affect the variance of real imports solely by altering the way debt service is paid? The answer, says Warner, is a qualified yes.

The presumption that fixed-rate debt is less risky than flexible-rate debt is historically inaccurate as a general proposition. Using annual data for 1970-90, Warner shows that for many developing countries, flexible-rate borrowing actually reduced net risk — whether debt service payments were indexed to nominal interest rates or to inflation in industrial countries. The covariance terms are larger and more often positive with inflation than with nominal interest rates.

Warner presents a macro-model of the industrial countries to organize thoughts about the comovements of these variables in response to shocks. The terms of trade of developing countries are linked to this model by the assumption that the level of demand in industrial countries positively affects the terms of trade of developing countries.

The worst-case scenario for developing countries is flexible interest rate borrowing combined with monetary contraction in the industrial world, which raises nominal interest rates, reduces inflation, and worsens the terms of trade of developing countries. To the extent that developing countries want to avoid this scenario, borrowing at either fixed interest rates or inflation-indexed rates would be preferable to borrowing at flexible nominal interest rates.

To reduce risk, countries should seek debt contracts in which debt service payments vary positively with their terms of trade. Results indicate that inflation-indexed debt is most desirable on this score.

Warner examines only extreme options, with all debt of one type. The optimal strategy would probably entail all three kinds of borrowing. And the paper does not examine options for efficient international risk-sharing.

How Should Sovereign Debtors Restructure their Debts: Fixed Interest Rates, Flexible Interest Rates, or Inflation-Indexed?

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1. Introduction.

Should risk averse sovereign debtors borrow at fixed or flexible rates? And if borrowing at flexible rates, rather than paying a fixed premium over a nominal interest rate like LIBOR, would it be in the interests of the country to pay instead a fixed premium over the inflation rate in the currency of the lending bank?

These questions have gained renewed importance as several debtors have already shifted, or are now actively considering a shift from flexible to fixed rate debt. This shift is motivated by the belief that fixed rate borrowing is less risky than flexible rate borrowing, and that in particular, it helps insure debtors against a repeat of 1982, when the combination of flexible rate borrowing, high nominal interest rates, and declining terms of trade helped precipitate the debt crisis. At issue is whether this presumption is warranted after framing the question in a more general framework that does not exclusively rely on the 1982 example.

Consider briefly the choice between fixed interest rate debt and flexible interest rate debt. To decide the issue for a given country, it would be helpful, although perhaps infeasible, to know both the future path of nominal interest rates and the covariance between interest rates and other sources of income. For concreteness, assume that the country desires both low debt service payments and a low variance of its real purchasing power over imports. The future path of interest rates matters because one may wish to lock in now if rates are temporarily low, and borrow at flexible rates if they are temporarily high. The covariance matters because if it is *positive* and sufficiently large, then floating rate debt can actually reduce the overall variance of real imports, and in this sense be *less* risky than fixed rate debt.

The purpose of this paper is to flag some of the relevant macroeconomic issues and to provide useful guidelines for policy makers dealing with these issues.

Since all recommendations require clarity about the objectives, this paper begins by assuming that the objective is to minimize the variance of real purchasing power over imports, although some other

objectives are also considered. It is worth stating explicitly that this objective is best suited to the case where countries have inherited debt, and have little ability to borrow and lend on international capital markets to insulate real imports against the effects of temporary shocks. Clearly if countries could borrow freely, then borrowing would be a simpler way to deal with temporary interest rate shocks and, consequently, the choice of debt contract would be less important. The assumption is also best suited to the case where countries import essential intermediate inputs and capital goods. In this situation, a shock to interest payments can also become a supply shock by compressing essential imports, which would have further ramifications on the real side of the economy. However, both of these cases, limited access to global credit markets, and a high intermediate and capital goods content of imports, are arguably important facts that currently confront developing countries.

To place this paper in a wider context, it is part of a literature that looks at ways developing countries can reduce their exposure to risk from fluctuating export prices. There are three broad approaches to this problem. The first is to seek ways to intervene in the market to control export prices. Examples include buffer stocks and funds, quotas and variable export taxes. There is already an extensive literature analyzing and criticizing these schemes (see Newbery and Stiglitz, 1981). A second approach is to make better and more extensive use of market mechanisms for managing risks, such as insurance markets, forward, futures and options markets. But several authors, (see Arrow, 1974), argue that there are entrenched sources of market failure that make replication not possible with these instruments for developing countries. A third alternative is to design financial instruments that can serve as hedging instruments in addition to their function as financing instruments. Examples include swaps, commodity-linked bonds and indexed variable rate loans. With the possible exception of the recent past, developing countries have not made full use of the range of feasible instruments.

Within this last alternative, the merits and demerits of commodity-linked bonds have been examined by Meyers (1990). This scheme is best suited for countries whose exports are dominated by

homogenous commodities. In the case where countries export a range of commodities and where the composition changes over time, it is less obvious how to implement such a scheme.

To avoid analyzing what the literature has already covered, this paper does not consider commodity-linked bonds, and instead focusses on three options which are closer to what developing countries are already doing or at least closer in spirit. The three options are, first, borrowing at fixed interest rates without any indexing; second, indexing to a nominal interest rate; and finally, indexing to an inflation rate. The last option is not commonly considered, but the paper will show a case where it can achieve better diversification than nominal interest rate indexing. Essentially it amounts to guaranteeing a fixed real interest rate to the creditor bank, since the interest rate paid can be set at a fixed markup over inflation in the home currency of the bank.

1. The Countries.

To provide an idea of the list of countries that such a question would be relevant for, table 1 presents statistics on the amount of commercial bank debt and variable rate debt. The country list is restricted to countries that owed at least 5 percent of their long term debt to commercial banks in 1991. The debt data are expressed in millions of US dollars.

Table 1. The Importance of Commercial Bank Debt and Variable Rate Debt, 1991

COUNTRY	Long Term Debt (LDOD)	Percent to Commercial Banks	Percent at Variable Rates
AGO.ANGOLA	7370	10.3	6.5
ARG.ARGENTI	47188	49.0	58.3
BGR.BULGARI	11023	47.6	73.0
BOL.BOLIVIA	3676	9.8	24.2
BRA.BRAZIL	95130	54.3	71.8
BRB.BARBADO	483	37.3	24.6
CHL.CHILE	14744	60.4	76.6
CHN.CHINA	50502	29.4	33.1
CIV.COTE D'	15167	48.9	65.7
CMR.CAMEROO	5254	11.0	18.7
COG.CONGO	3989	10.5	27.3
COL.COLOMBI	15617	33.7	50.6
CRI.COSTA R	3620	8.9	32.1
CSK.CZECHOS	5846	43.0	33.3
CYP.CYPRUS	1513	28.0	31.0
DOM.DOMINIC	3554	24.2	31.5
DZA.ALGERIA	26557	20.0	41.6
ECU.ECUADOR	10094	50.0	61.0
FJI.FIJI	346	24.3	31.5
GAB.GABON	2935	6.2	10.2
GTM.GUATEMA	2230	12.3	16.8
GUY.GUYANA	1554	5.1	10.4
HND.HONDURA	2940	7.8	21.7
HTI.HAITI	609	7.6	0.7
HUN.HUNGARY	19221	42.3	56.4
IDN.INDONES	59960	27.9	43.1
IND.INDIA	64315	13.3	21.0
IRN.IRAN, I	2736	38.6	84.7
JAM.JAMAICA	3779	8.3	25.7
JOR.JORDAN	7570	15.9	28.2
KEN.KENYA	5776	27.1	20.2
KOR.KOREA,	29318	36.8	41.8
LBR.LIBERIA	1127	15.5	10.9
LKA.SRI LAN	5758	6.9	5.6
MAR.MOROCCO	20332	16.6	52.5
MEX.MEXICO	83891	15.3	45.9
MUS.MAURITI	960	28.9	11.0
MYS.MALAYSI	18753	34.3	52.2
NER.NIGER	1503	16.1	16.4
NGA.NIGERIA	33588	17.7	31.8
NIC.NICARAG	8703	14.9	25.9
OMN.OMAN	2270	71.3	59.6
PAN.PANAMA	3939	54.1	61.3
PER.PERU	15298	25.8	27.8
PHL.PHILIPP	25893	28.1	41.7
PNG.PAPUA N	2565	46.6	52.7
POL.POLAND	44057	23.1	67.7
PRT.PORTUGA	20170	46.0	27.0
PRY.PARAGUA	1800	16.6	16.8
SDN.SUDAN	9717	21.4	19.6
SLV.EL SALV	2069	8.0	14.1
SYC.SEYCHEL	154	16.2	8.4
THA.THAILAN	23336	54.0	56.6
TTO.TRINIDA	1817	32.0	51.7
TUN.TUNISIA	7369	6.7	23.4
TUR.TURKEY	41135	33.2	35.5
URY.URUGUAY	3128	20.6	60.1
VEN.VENEZUE	28839	13.1	62.7
YUG.YUGOSLA	15872	56.5	75.1
ZAR.ZAIRE	9151	5.7	15.3
ZWE.ZIMBABW	2868	14.4	26.8

Debt is measured in millions of 1991 U.S. dollars. Source: World Bank: World Debt Tables, 1992.

2. When will flexible rate debt be less risky than fixed rate debt?

It was mentioned in the introduction that flexible rate debt may actually be *less* risky than fixed rate debt as long as the covariance term is large enough to overcome the higher variability of flexible rate debt. Of course, this may hold for either of the two kinds of flexible rate debt, nominal interest rate indexed or inflation indexed, but the equations below are written for the case of nominal interest rate indexing. This section derives a condition on the covariance term to gauge when flexible rate borrowing has a lower variance that fixed rate borrowing, and then examines data to determine the extent to which this criterion was satisfied in the past.

First, let P_x and P_m represent aggregate export and import price indexes with 1987=1.0; let x represent real exports in billions of 1987 dollars; let i and θ represent the nominal interest rate on outstanding debt and the fraction of principal that is repaid each year; and let D represent outstanding debt in billions of 1987 dollars. Then the quantity of real imports that can be purchased in a given year without borrowing is simply:

$$\frac{P_x}{P_m}x - (i+\theta)\frac{D}{P_m}$$

To simplify the notation and the analysis slightly, assume $\theta=0$ and rewrite the expression as follows.

$$z = px - id$$

Where p is the terms of trade, x is real imports, and d is real debt measured in terms of the aggregate import good. Taking exports and debt as pre-determined, and the terms of trade and the nominal interest rate as stochastic, the variance of real import purchases under flexible rate borrowing would be:

$$Var(px - id) = x^2Var(p) + d^2Var(i) - 2xdCov(p,i)$$

And the variance under fixed interest rate borrowing would be:

$$Var(px - id) = x^2Var(p)$$

Hence flexible rate borrowing can achieve a lower variance of real import purchases when

$$d^2Var(i) - 2xdCov(p,i) < 0.$$

Re-writing this condition, we have

$$\beta_I = \frac{Cov(p,i)}{Var(i)} > \frac{d}{2x} . \qquad (6)$$

To interpret this condition, note first that the coefficient from a simple bivariate regression of the terms of trade on nominal interest rates provides an estimate of the left hand side; and the right hand side is simply one-half the debt to export ratio. Hence the condition states that flexible rate borrowing will be less risky than fixed interest rate borrowing if the regression coefficient is *positive* and exceeds one half the debt export ratio.

The next question is whether this condition has been satisfied in practice. To answer this question, table 2 reports sample estimates of the left hand side of (6), denoted by β, using both a representative nominal interest rate (Dollar LIBOR rate) and inflation (US inflation using the GDP deflator). The estimates of the β's use 20 years of annual data covering the period 1970-1990; and the estimates of the term d/2x uses 1990 data. The debt term (d) is total long term debt owed to commercial banks in 1990.

The evidence indicates that when the β's are estimated using nominal interest rates, the inequality is satisfied in about a third of the cases (21 out of 61 countries); using inflation the inequality is satisfied in just under 90 percent of the cases (54 of 61). Therefore, the past twenty years of data indicate that in many countries inflation-indexed debt is more likely to satisfy the lower variance criteria than interest-rate-indexed debt. Also notice that the estimates of β are typically sufficiently large that the question of whether (6) is satisfied does not hinge importantly on the debt term used to compute d/2x.

Table 2. Has the inequality in (6) been satisfied?
(annual data, 1970-1990)

COUNTRY	Estimate of β_p	Standard Error	Estimate of β_i	Standard Error	d/2X
AGO ANGOLA	13.64	2.52	10.10	2.45	0.13
ARG.ARGENTI	4.52	2.39	-1.53	2.11	1.30
BCR.BULGARI	5.03	1.62	-2.04	1.44	0.34
BOL.BOLIVIA	8.19	3.02	9.19	2.32	0.19
BRA.BRAZIL	2.23	3.04	-5.11	2.22	1.08
BRE.BARBADO	7.10	1.57	2.77	1.76	0.23
CHL.CHILE	4.50	5.62	-4.46	4.55	0.74
CHN.CHINA	1.45	0.64	0.74	0.56	0.16
CIV.COTE D'	1.52	1.76	-0.40	1.54	1.10
CMR CAMERCO	5.10	2.63	0.44	2.34	0.20
COG.CONGO	1.8	2.56	5.95	1.65	0.21
COL.COLOMBI	3.	2.85	1.30	2.51	0.30
CRI.COSTA R	1.90	1.74	-1.91	1.41	0.08
CSK.CZECHOS	3.62	1.32	-1.36	1.26	0.11
CYP.CYPRUS	-0.40	2.07	-2.9	1.56	0.16
DOM.DOMINIC	8.19	2.93	-2.04	2.86	0.40
DZA.ALGERIA	3.87	4.80	12.52	2.81	0.28
ECU.ECUADOR	2.28	3.41	4.94	2.66	1.03
FJI.FIJI	18.77	3.93	0	4.67	0.07
GAB.GABON	2.93	3.40	0	1.93	0.05
GTM.GUATEMA	2.67	2.13	-2.84	1.74	0.11
GUY.GUYANA	9.12	2.88	-1.53	2.91	0.23
HND.HONDURA	0.80	1.71	-2.54	1.30	0.17
HTI.HAITI	-0.5	0.97	-1.53	0.80	0.14
HUN.HUNGARY	1.67	1.11	-0.73	0.96	0.37
IDN.INDONES	2.14	3.16	7.54	1.97	0.39
IND.INDIA	-1.36	1.36	-2.33	1.01	0.20
IRN.IRAN, I	5.92	4.87	13.96	2.79	0.07
JAM.JAMAICA	1.42	1.06	-1.83	0.85	0.09
JOR.JORDAN	1.91	1.30	-1.92	1.03	0.25
KEN.KENYA	2.27	1.50	-0.39	1.32	0.39
KOR.KOREA,	-0.29	1.61	-2.79	1.15	0.11
LBR.LIBERIA	0.97	2.42	-3.16	1.88	0.32
LKA.SRI LAN	0.83	1.85	-1.70	1.53	0.09
MAR.MOROCCO	3.08	1.43	-1.90	1.23	0.35
MEX.MEXICO	3.66	2.13	1.30	1.91	0.23
MUS.MAURITI	3.07	1.50	-2.25	1.28	0.09
MYS.MALAYSI	2.67	1.10	2.50	0.93	0.10
NER.NIGER	4.03	3.06	-2.42	2.68	0.37
NGA.NIGERIA	4.71	4.81	13.23	2.77	0.30
NIC.NICARAG	4.32	2.64	-2.15	2.31	. 5
OMN.OMAN	7.90	5.32	14.76	3.25	0.19
PAN.PANAMA	1.47	1.07	-0.14	1.01	0.47
PER.PERU	6.51	3.46	-0.43	3.31	0.70
PHL.PHILI	2.13	2.51	-2.26	2.05	0.40
PNG.PAPUA N	4.08	2.13	-1.25	2.01	0.41
POL.POLAND	1.17	0.77	-0.90	0.63	0.28
PRT.PORTUGA	0.42	1.33	-2.24	0.97	0.34
PRY.PARAGUA	5.83	5.55	-5.38	4.48	0.13
SDN.SUDAN	2.12	2.67	-1.43	2.31	3.48
SLV.EL SALV	2.07	2.62	-2.33	2.15	0.10
SYC.SEYCH	2.28	2.51	6.12	1.61	0.07
THA.THAIL	5.84	2.31	-1.31	2.22	0.30
TTO.TRINID	5.25	2.17	6.29	1.53	0.17
TUN.TUNISIA	2.27	1.09	3.41	0.63	0.06
TUR.TURKEY	-0.32	1.91	-3.33	1.36	0.56
URY.URUGUAY	1.94	3.81	-4.60	2.95	0.22
VEN.VENEZUE	4.03	5.07	13.19	2.97	0.17
YUG.YUGOSLA	-2.45	1.32	-1.31	1.13	0.31
ZAR.ZAIRE	4.28	4.31	-2.73	3.53	0.17
ZWE.ZIMBABW	3.33	2.90	-2.51	2.41	0.13

Using y to stand for either i or p, $\beta_y = \mathrm{Cov}(p,y)/\mathrm{Var}(y)$, corresponding to the left side of the inequality in (6). The estimates of the β's use annual data, 1970-1990. The term d/2X is measured with 1990 data, and corresponds to the right of (6).

The data summarized in the preceding section show that the covariance terms have been large enough to make a difference. Given this evidence, this section presents a model to think more systematically about the ultimate sources of co-movements between the key economic variables. The model is a closed economy model of the OECD block which determines OECD nominal interest rates and inflation as a function of exogenous monetary policy, fiscal policy and oil price variables. Developing economies are linked to this block with the assumption that their terms of trade respond to the level of demand in the developed world.

The model may be seen as a leaner version of more elaborate models such as McKibbin and Sachs, 1991. Since the main purpose is expository, I have deliberately chosen simplifications which focus on the main points. All of the qualitative effects which underlie the conclusions in this paper have been replicated with simulations of the McKibbin and Sachs model.

To repeat, the model determines the three main variables of interest, nominal interest rates, OECD inflation, and the external terms of trade of less developed countries, and distinguishes between short run and long run effects. The exogenous variables are an OECD fiscal variable, g, a money supply variable, m, and world oil prices, p_{oil}. All variables are in natural logs.

$$y = \beta y - \alpha(i - \dot{p}) + g \tag{7}$$

$$m - p = \theta y - \lambda i \tag{8}$$

$$\dot{p} = \gamma(y - \bar{y}) \tag{9}$$

$$p_c = y \tag{10}$$

$$\bar{y} = -\mu p_{oil} \tag{11}$$

Equation (7) is a semi-reduced form equilibrium condition for the goods market. Aggregate demand on the right hand side is a function of output, the real interest rate, and a fiscal variable. Equation (8) is a conventional money market equation, where money demand depends on output and the opportunity cost of holding money, given by the nominal interest rate. Equation (9) is a simple Phillips curve that expresses inflation as a function of the gap between current output and potential output. The assumption is that the OECD price level, p, cannot jump in response to shocks in the short run, and instead adjusts gradually over time according to (9). In this sense the model shares the price stickiness assumption of static Keynesian models. Equation (10) (with p_c representing the terms of trade of developing countries) embodies a purely demand side view of terms of trade determination. And equation (11) is a production function where labor and capital are not written explicitly, since they will be held constant in the experiments. The price of oil is modelled to reduce potential output because it is a key

intermediate in OECD economies. This is similar to the way oil prices are treated in Bruno and Sachs (1985), and is supported by econometric evidence that energy and capital are complements, (see Berndt and Wood (1979)).

Although the main points of the model will be presented graphically, it is worth documenting the algebraic solution in addition. Treating the long run or steady state solution first, inflation is zero by assumption and hence output equals potential output from equation (9). Equations (7) and (8) then jointly determine the long run level of nominal interest rates and the price level. The full solution is in equations (12) to (17) below.

$$\dot{p} = 0 \tag{12}$$

$$\bar{y} = -\mu p_{oil} \tag{13}$$

$$y = \bar{y} \tag{14}$$

$$i = \frac{1}{\alpha}\left(g - (1-\beta)\bar{y} \right) \tag{15}$$

$$p = \frac{\lambda}{\alpha} g - \left[\frac{\lambda(1-\beta)}{\alpha} + \theta \right] \bar{y} + m \tag{16}$$

$$p_c = y \tag{17}$$

Of this set of equations, the most relevant for the question at hand is the nominal interest rate

equation (15). It is worth noting that since inflation is zero, this equation is also a real interest rate equation. Note that real interest rates are permanently raised by a permanent rise in government spending. The reason is that with output fixed at its full employment level, the real interest rate must rise to shift demand from the private sector to the government. A rise in oil prices also raises the real interest rate in the long run because it reduces value-added output, and with nothing else changing on the demand side, real interest rates must rise to bring demand to this lower level (the term $1-\beta$ is assumed to be a positive fraction). Finally, a rise in the money supply increases p proportionally in the long run and has no effect on the other variables of interest.

According to this model one would not want to borrow at flexible interest rates if a fiscal expansion is anticipated, since this will simply raise OECD interest rates and developing country debt service payments. It is also clear that an oil price increase is the worst of all possible outcomes for non-oil exporting developing countries, since both OECD output and developing country commodity prices will fall at the same time that OECD interest rates rise. If such an event is anticipated, then fixed rate borrowing will at least insulate developing countries from higher future interest rates. On the other hand, flexible rate borrowing would be better if oil prices were expected to come down, since the future interest rate decline would work in favor of indebted developing countries.

Between steady states, the price level is treated as a slowly adjusting variable whose motion is governed by equation (9). Hence (7) (8) and (9) are solved simultaneously for output, nominal interest rates and inflation. The solution is given below.

$$\dot{p} = \gamma(y - \bar{y}) \tag{18}$$

$$\bar{y} = -\mu p_{oil} \tag{19}$$

$$y = \frac{\alpha(m-p) + \lambda(g-\alpha\gamma\bar{y})}{\alpha\theta + \lambda(1-\beta-\alpha\gamma)} \tag{20}$$

$$i = \frac{-(1-\beta-\alpha\gamma)(m-p) + \theta(g-\alpha\gamma\bar{y})}{\alpha\theta + \lambda(1-\beta-\alpha\gamma)} \tag{21}$$

$$p_c = y \tag{22}$$

This set of equations are best suited to analyze the short term co-movements in p_c, i, and inflation induced by the three exogenous variables. First, by substituting equation (22) on the left of equation (20) and comparing this equation to equation (21), one can see that shocks to g cause a positive co-movement in developing country terms of trade and OECD nominal interest rates. Therefore, if the world were dominated by fiscal shocks, this pattern would favor developing countries that indexed their debt payments to nominal OECD interest rates. On the other hand, money supply shocks induce a negative short term co-movement which works against developing countries whose debt is structured in this way. (The term $1-\beta-\alpha\gamma$ is assumed to be a positive fraction.)

However, note from equation (18) and (22) that OECD inflation and developing country terms of trade always move in a positive relation in the short run under either monetary or fiscal shocks. Hence this model points out that improved diversification may be possible if developing countries indexed debt payments to (industrial country) inflation rather than nominal interest rates.

The effects of oil shocks on the co-movements between nominal interest rates, inflation and the terms of trade are not as easy to see from equations (18)-(21). To see the effects more clearly equations (22)-(24) below solve explicitly for these three variables.

$$\dot{p} = \gamma\left[\frac{\alpha(m-p) + \lambda(g+\alpha\gamma\mu p_{oil})}{\alpha\theta + \lambda(1-\beta-\alpha\gamma)} + \mu p_{oil}\right] \tag{23}$$

$$p_c = \frac{\alpha(m-p) + \lambda(g+\alpha\gamma\mu p_{oil})}{\alpha\theta + \lambda(1-\beta-\alpha\gamma)} \tag{24}$$

$$i = \frac{-(1-\beta-\alpha\gamma)(m-p) + \theta(g+\alpha\gamma\mu p_{oil})}{\alpha\theta + \lambda(1-\beta-\alpha\gamma)} \tag{25}$$

It is clear from these equations that oil shocks will move all three variables in the same direction. Hence the short run dynamics provide no basis on which to choose between inflation indexing and nominal interest rate indexing, but both achieve a positive co-movement that fixed rate debt would not achieve.

Having outlined the analytical solution of the model in both the long and the short run, the behavior of the model is summarized in figures 1 to 3, with figure 1 showing the response to a permanent OECD monetary expansion, figure 2 showing the response a permanent OECD fiscal expansion and figure 3 showing the response to a permanent rise in the price of oil.

3. Summary of policy recommendations from the model.

The policy prescriptions from such a model regarding fixed versus flexible rate borrowing can now be summarized (see also the summary in table 3). It should be stressed that these recommendations take into account only the direction in which the key variables move in response to shocks. When recommendations hinge on favorable co-movements between variables, it is implicitly assumed that the condition in equation (6) is satisfied.

Money Supply shocks.

If you know that a monetary expansion is on the horizon, then flexible nominal rate borrowing is best: you will benefit from the commodity price boom; and nominal rates will come down. Fixed rate borrowing simply will deprive you of the benefit from falling nominal rates. Inflation indexing is even worse because inflation will rise and you will incur higher debt service payments as inflation rises.

If you know that a monetary contraction is on the horizon, then inflation indexing is best: you will suffer a commodity price decline no matter what you do; but at least with inflation-indexing your debt service payments will come down as inflation comes down. In contrast, flexible nominal rate contracts expose you to higher debt service payments as nominal rates rise. Fixed rate contracts would not expose you to higher debt service payments, but would not be as good as inflation indexing.

If you do not know which way OECD monetary policy will turn, and just want insurance against any outcome, then inflation-indexed borrowing is best: the reason is that OECD inflation and commodity prices will vary positively in response to either a monetary expansion or contraction. Neither fixed nor flexible rate borrowing will achieve this kind of insurance.

Fiscal shocks.

If you know that a fiscal expansion is on the horizon, then fixed nominal rate borrowing is best: you will benefit from the commodity price boom; and lock in at currently low rates now before they go up. Flexible rate borrowing exposes you to interest rate increases both in the short and long term.

Inflation indexing is not as bad as interest rate indexing because the inflation increase would not be permanent (as the interest rate increase will be), but is still worse than fixed rate borrowing.

If you know that a fiscal contraction is on the horizon, then flexible nominal rate borrowing is best: the interest rate decline will cushion the decline in commodity prices, and you will benefit further in the long run as interest rates stay low (while commodity prices recover as OECD output returns to capacity). Fixed rate borrowing will lock you in to temporarily high interest rates and is therefore a bad idea. Inflation indexing is basically similar to nominal interest rate indexing in the short run, but is not as good in the long run because inflation will not stay low permanently as will nominal interest rates.

If you do not know which way OECD fiscal policy will turn, and just want insurance against any outcome, then inflation indexing is best: the reason is that OECD inflation and commodity prices will have a positive covariance under any fiscal shock. Neither fixed or flexible rate borrowing will achieve this kind of insurance.

Oil price shocks:

Non-oil exporting developing countries.

If you know that oil prices will rise, then fixed interest rate contracts are best. In the long run, the terms of trade will decline and interest rates will rise, so that flexible interest rate borrowing is bad idea. Inflation indexing is less bad than nominal interest rate indexing because the rise in inflation will not be sustained, but is still inferior to fixed rate borrowing.

If you know that oil prices will fall, then it is best to contract at flexible interest rates. In the long run, the terms of trade will rise and interest rates will fall. Since interest rates will fall permanently while inflation will not, inflation indexing is inferior to nominal interest rate indexing.

When oil price movements are uncertain, both forms of indexing are risky because the costs can be quite high if oil prices increase. Hence fixed interest rate contracts are safer.

Oil-exporting developing countries.

If you know that oil prices will rise then fixed interest rate contracts are best because you will avoid paying higher nominal interest rates. If you know that oil prices will decline, then flexible interest rate contracts are best so that you can benefit from lower interest rates. If future oil prices are uncertain, then note that both oil prices and nominal interest rates vary positively in both the short and long runs: hence flexible interest rate contracts can provide insurance against large shocks to real imports.

Table 3. Summary of policy recommendations from the model

Contingency		Preferred contract
Money	Expansion	flexible i
	Contraction	inflation indexed
	Insurance	inflation indexed
Fiscal	Expansion	fixed i
	Contraction	flexible i
	Insurance	inflation indexed
Oil-importing countries:		
Oil Price	Rise	fixed i
	Fall	flexible i
	Insurance	fixed i
Oil-exporting countries:		
Oil Price	Rise	fixed i
	Fall	flexible i
	Insurance	flexible i

4. Possible modifications to the model.

One possible objection to the model so far is that equation (10) assumes that the terms of trade of developing countries is solely a function of demand in industrialized countries. An alternative approach would be to emphasize that less developed countries tend to export commodities and thus use a more explicit model of commodity price formation. For example, under the competitive model of commodity price formation with storage, commodity prices would be affected by real interest rates in addition to other variables. The reason is that if the commodities are storable, there is an arbitrage equation equating the required rate of return (real interest rate) with expected capital gain in commodity prices. Under this model, for a given level of expected future commodity prices, a rise in the real interest rate would depress current commodity prices (this argument goes back to Hotelling, 1932).

How would the conclusions change if this effect (higher real interest rates depressing the terms of trade) were added to equation (10)? First, this change would reinforce the conclusions regarding monetary shocks. The reason is that a monetary expansion strongly depresses real interest rates, raising commodity prices at the same time that it raises aggregate demand. Hence the real interest rate effect would reinforce the demand effect on the terms of trade. However, with fiscal shocks the conclusions would be reinforced in the short run but offset in the long run. The reason they would be offset is that a permanent fiscal expansion raises real interest rates in the long run, thus lowering commodity prices below the level they would obtain in the absence of the real interest rate effect. Finally, the addition of real interest rate effects on commodity prices would offset the demand effects of oil price shocks. Higher oil prices depress real interest rates in the short run and raise them in the long run; exactly the opposite of the demand effect.

A second possible objection is that the model only incorporates the effect of oil prices on potential output, to the exclusion of demand effects. To the extent that higher oil prices raise inflation and nominal interest rates under-adjust to inflation, the model can yield lower real interest rates in response to oil price

increases. Since output in the short run is demand determined, these lower real rates stimulate demand and output. This result of higher oil prices stimulating OECD output in the short run seems sharply at odds with the evidence of the 1970s. To resolve this issue, oil prices could be directly added to the right hand side of equation (7), to depress aggregate demand through income or wealth effects. The effect of oil prices on output would then depend on the magnitude of parameters. However, since none of the main conclusions of this paper depend on the short run output effects of oil prices, this modification is not pursued.

5. Wealth effects and access to financing.

Earlier parts of this paper analyzed issues that come into play when countries cannot borrow freely on international capital markets to finance temporary shocks to their balance of payments. Different issues are relevant in the intermediate case where countries have some access to financing but their access is sensitive to perceptions about the solvency of the country by potential creditors.

When a country experiences a decline in export revenues, and the decline is severe enough that the international financial community questions the solvency of the country, it is important that the form of debt contract the country has adopted does not exacerbate the situation by lowering the likelihood that the country can obtain financing. This section presents a simple framework to show how this can happen, and then asks what the evidence of the past 20 years suggests about the importance of the form of debt contract for this issue.

It is first necessary to write some model of how the international financial community evaluates a country's creditworthiness. For this purpose, assume that potential creditors use the present value model to evaluate creditworthiness. That is, they compute the present discounted value of exports and debt service payments on the (admittedly naive) assumption that variables such as interest rates and exports will remain constant in the future at current levels. This provides one possible measure of a country's capacity to repay additional debt, and it is assumed further that access to financing depends on the difference between this computation of export wealth and debt liability. This procedure is crude, but it does have the virtue of matching what many allege is standard practice in country risk analysis in major banks.

Concerning the asset side of this calculation, let current nominal exports be given by x(t) and let the current (and therefore expected future) growth in nominal exports be $\pi_x(t)$. Using the current nominal interest rate as the discount rate, nominal export wealth, W_x is finite as long as the discount rate exceeds export growth,

$$W_x(t) = \frac{x(t)}{i(t)-\pi_x(t)} \qquad if \quad i(t)-\pi_x(t) > 0 \tag{26}$$

and infinite if export growth exceeds the discount rate, $i(t) - \pi_x(t) < 0$.

On the other side of the balance sheet, the countries' liabilities are the present discounted value of expected future debt service payments. These payments differ according to the form of debt contract. Abstracting from several details about the debt contracts, with flexible rate borrowing debt service payments would essentially be $i(t) * D(t)$, while under fixed interest rate borrowing they would be $i * D(t)$ and under inflation indexing they would be $\pi(t) * D(t)$. The main point to note is that the interest rate term cancels out of the present discounted value calculation with flexible interest rate borrowing but does not under the two alternatives:

$$\textit{Under flexible rate: } \int_t^{\infty} e^{(s-t)i}\, iD\, ds = D(t), \tag{27}$$

$$\textit{Under fixed rate: } \int_t^{\infty} e^{(s-t)i}\, \bar{i}D\, ds = \frac{\bar{i}D(t)}{i(t)}, \tag{28}$$

$$\textit{Under an indexed rate: } \int_t^{\infty} e^{(s-t)i}\, \pi D\, ds = \frac{\pi(t)D(t)}{i(t)}, \tag{29}$$

Combining these liabilities with the export wealth calculation in (26), the perceived net worth of

the country under the three kinds of borrowing (flexible interest rate, fixed interest rate, and inflation indexed) can be represented as follows.

$$\textit{Under flexible rate:} \quad W = \frac{x}{i-\pi_x} - D \tag{30}$$

$$\textit{Under fixed rate:} \quad W = \frac{x}{i-\pi_x} - \frac{\bar{i}D}{i} \tag{31}$$

$$\textit{Under an indexed rate:} \quad W = \frac{x}{i-\pi_x} - \frac{\pi D}{i} \tag{32}$$

These calculations are for the case where the interest rate exceeds export growth, which is precisely the case where solvency can be questioned. In the other case when export growth is high, solvency is less likely to be a real issue. The important point to note from equations (30) - (32) is that the difference between them is due to the terms $\bar{i}/i$ and π/i in (31) and (32). Hence knowing more about the relationship between shocks to export wealth and shocks to these two terms is important in assessing the contracts under question.

Annual data was collected on i (nominal LIBOR), π (US GNP deflator), x, and π_x, for the 61 developing countries covering the years 1970-1990. Export wealth, W_x, was then calculated in all cases where export growth was sufficiently low, $\pi_x < i$. Since export growth was typically higher than i, this condition reduced the number of usable observations sufficiently that it was decided to pool the data rather than examine individual countries. We then look at the conditional distribution of $\Delta(\bar{i}/i)$ and $\Delta(\pi/i)$ given that countries experienced negative shocks to export wealth ($\Delta W_x < 0$).

The reason for conditioning on the event $\Delta W_x < 0$ is that years in which export wealth declined represent potential crisis years in which financing may have been at risk. The debt contract would soften

the blow in these years if liabilities as perceived by external financiers also declined during these years. Therefore the more the conditional density is shifted to the left, the better.

Figures 1 and 2 present the empirical frequency distributions for the cases of inflation-indexed and fixed interest rate borrowing ($\bar{i}$ is set at 0.05). On the basis of the evidence from the past 20 years displayed in these figures, there are grounds for slightly preferring inflation indexing over the other kinds of borrowing, but the evidence is not strong. The mean of the density in figure 1 is -0.000103, that of figure 2 is 0.000815. Given the standard errors of 0.0011 and 0.0012 respectively, neither mean is significantly different from 0 and the means are not significantly different from each other. Therefore, although access to financing may be an important concern, there is not strong evidence from the past 20 years that the form of debt contract affects this significantly.

6. How much difference would inflation-indexing have made?

Much of this paper has suggested that inflation indexing would have been superior to nominal interest rate indexing or fixed interest rate borrowing. For example, the data in table 2 show that the condition in (6), namely that Cov(p,j)/Var(j) > d/2x, is satisfied for a larger group of countries when j = U.S. inflation than when j = U.S. nominal interest rates. In addition, when the world is dominated by monetary shocks emanating from the high income economies, the model provides a reason to exect that the terms of trade in low income economies will vary together with inflation in the high income economies, but will vary inversely with nominal interest rates in the high income economies. Hence under monetary shocks, the variance of equation (2), that is, the variance of z(j) = px - jd, should be lower when j = inflation than when j = nominal interest rates, and in this sense inflation indexing should achieve better insurance for lower income economies. The z's have welfare significance because they measure the quantity of real imports that a country could purchase without any external borrowing or lending.

Given these prior results, the next natural question is the following. Suppose developing countries had their debt indexed to inflation rather than to nominal interest rates during the past 20 years. How much difference would it have made? To answer this, z(j) = px - jd was simulated using actual data for p, x, and d, combined with six alternatives for j. The first three of these were flexible interest rate simulations, where j was the nominal 3-month government bond rate for Germany and Japan and the 3-month dollar LIBOR rate for the U.S.; and in the remaining three simulations, j was GDP-deflator inflation for the same three countries plus a real interest rate markup. This markup was set equal to the average ex-post real interest rate over the period 1970-1990, using the same interest rates and inflation rates. These real interest rates were 0.035 for Germany, 0.023 for Japan and 0.033 for the United States. So for each developing country, six time series using annual data during the period 1970-1990 were generated for z(j), corresponding to j = ($i_{DEU}, i_{JPN}, i_{USA}$, $\pi_{DEU}+0.035, \pi_{JPN}+0.023, \pi_{USA}+0.033$). Finally,

to eliminate the trend due to population growth, each time series of z(j) was divided by population in the relevant developing country.

To compare the two broad alternatives of borrowing at flexible nominal interest rates or inflation indexing, table 4 reports sample variance ratios of the simulated z's divided by population. The first column uses U.S. inflation and interest rates, the second uses German data and the third uses Japanese data. Since in each column the numerator is the variance for inflation indexing, a value below 1.0 reveals that inflation indexing would have entailed lower variance than interest rate indexing. The table shows that there are many countries where this would have been the case, and in some of these the difference in variance would have been substantial. However, there is considerable dispersion across countries so that generalizations are not very informative. But the table does show that the reduction in variance from inflation-indexed borrowing can be substantial for particular countries.

Table 4. Inflation indexing versus interest rate indexing: variances

	$V(z(\pi_{USA}+.033))/V(z(i_{USA}))$	$V(z(\pi_{DEU}+.035))/V(z(i_{DEU}))$	$V(z(\pi_{JPN}+.023))/V(z(i_{JPN}))$
ARG	0.61	0.94	0.89
BGR	1.03	0.99	0.98
BOL	0.79	0.97	0.86
BRA	0.97	1.23	1.45
CHL	0.89	1.02	1.18
CHN	1.01	1.03	1.05
CIV	0.82	0.86	0.76
CMR	1.12	1.01	1.08
COG	1.28	1.11	1.22
COL	0.90	1.05	1.27
CRI	0.60	0.83	0.75
CSK	1.05	1.01	1.03
DOM	0.79	0.92	0.77
DZA	1.12	1.05	1.13
ECU	1.01	1.04	1.10
FJI	0.96	0.99	0.94
GAB	0.96	1.00	0.98
GTM	0.91	0.95	0.90
GUY	0.88	0.91	0.82
HND	0.85	0.87	0.80
HTI	1.09	0.99	1.12
HUN	1.12	1.12	1.19
IDN	1.10	1.09	1.20
IND	1.02	1.38	2.19
IRN	1.00	1.00	1.00
JAM	0.69	0.75	0.70
JOR	1.13	1.10	1.21
KEN	0.83	0.87	0.75
KOR	1.02	1.02	1.04
LBR	0.93	0.94	0.89
LKA	1.08	1.06	1.45
MAR	0.69	0.87	0.71
MEX	1.65	1.42	1.70
MUS	1.00	1.01	1.02
MYS	1.04	1.04	1.08
NER	0.93	0.93	0.93
NGA	0.98	0.99	0.98
NIC	0.86	0.88	0.75
PAN	1.09	1.07	1.14
PER	0.96	0.94	1.01
PHL	0.74	0.91	0.76
PNG	0.92	1.02	0.80
POL	1.01	1.18	1.27
PRT	0.99	1.03	1.06
PRY	0.99	1.04	1.08
SLV	0.89	0.94	0.90
SYC	1.03	1.05	1.06
THA	1.00	1.04	1.06
TTO	0.98	0.97	0.95
TUN	1.16	1.16	1.26
TUR	1.09	1.08	1.14
URY	0.97	1.04	1.35
VEN	0.99	1.01	0.99
ZAR	0.94	0.93	0.84
ZWE	0.93	0.94	0.88
Average	0.97	1.01	1.04

7. Summary and main conclusions.

This paper basically attempts to answer the following question. Does theory and the evidence from the past twenty years provide grounds for thinking that developing countries can affect the variance of real imports soley by altering the way debt is paid? The answer is a qualified yes. More specifically, the paper makes the following points.

The paper first shows that if there is a presumption that fixed rate debt is less risky than flexible rate debt, then this presumption is historically inaccurate. For many developing countries, using annual data over the period 1970-1990, the relevant covariance terms are sufficiently large that flexible rate borrowing can actually reduce overall risk. This statement is true whether debt service payments are indexed to industrial-country nominal interest rates or inflation. But it is noteworthy that the covariance terms are larger and more often positive with inflation than with nominal interest rates.

The paper then presents a macro-model of the industrialized countries to organize thinking about the co-movements of these variables in response to shocks. The terms of trade of less developed countries are linked to this model by the assumption that the level of demand in industrialized countries positively affects their terms of trade. The model rules out causality running from the terms of trade of developing countries to the indistrialized country equilibrium.

The worst case scenario for many developing countries is flexible interest rate borrowing combined with a monetary contraction in the industrialized world. A monetary contraction raises nominal interest rates, reduces inflation and reduces the terms of trade of developing countries. As happened in the early 1980s, developing countries whose debt service payments depend on nominal interest rates will suffer because the terms of trade decline at the same time that debt service payments rise. To the extent that countries wish to avoid this scenario, either fixed interest rate debt or inflation indexing would be preferable to borrowing at flexible nominal interest rates.

More generally, paper points out that to reduce risk countries should seek debt contracts where

debt payments vary positively with their terms of trade. Several of the results in this paper point to inflation-indexed debt as being desirable on this score.

First, using data from the period 1970-1990, the covariance between developing country terms of trade data and OECD inflation is generally positive and larger than the covariance using nominal interest rates. Second, the model offers a reason for this observation. Nominal interest rates in industrialized countries should vary inversely with monetary shocks in industrialized countries, but inflation in industrialized countries and the terms of trade of developing countries should vary positively with monetary shocks. To the extent that this kind of monetary shock was part of the mix of shocks affecting the world economy in the past twenty years, the stronger positive relation between developing country terms of trade data and OECD inflation than with OECD interest rates is not surprising. Third, simulations using actual data indicate that many developing countries could have achieved less variation in their imports if all of their debt was inflation-indexed rather than nominal interest rate indexed.

It is also worth pointing out what the paper does not do. First, the paper examines effects on the variance of real imports rather than the mean or other aspects of the distribution. This is not to deny that higher mean import purchases would be beneficial, instead it reflects scepticism that there is anything constructive too add on this issue. Of course, if countries could lock-in their debt at a very low rate, then they should do so. But there is no strong reason to think that developing countries can out-forecast their creditors about the future path of interest rates. Second, the paper examines only extreme options: either the debt is all inflation indexed, all interest rate indexed or all fixed rate debt. The reason for doing so is to bring out the contrasts between these options. It should be clear that the optimal strategy would probably entail all three kinds of borrowing.

Finally, the paper does not analyze the issues from the perspective of the creditor banks, and therefore does not fully examine risk sharing issues. For example, it may be the case that creditors would welcome the introduction of inflation-indexed bonds as an additional asset to minimize their own

risk, (these are not widely available in industrialized countries) and thus there may be some scope for more efficient international risk sharing.

Figure 1. The time path of nominal interest rates, inflation and commodity prices in response to a permanent monetary expansion in the OECD.

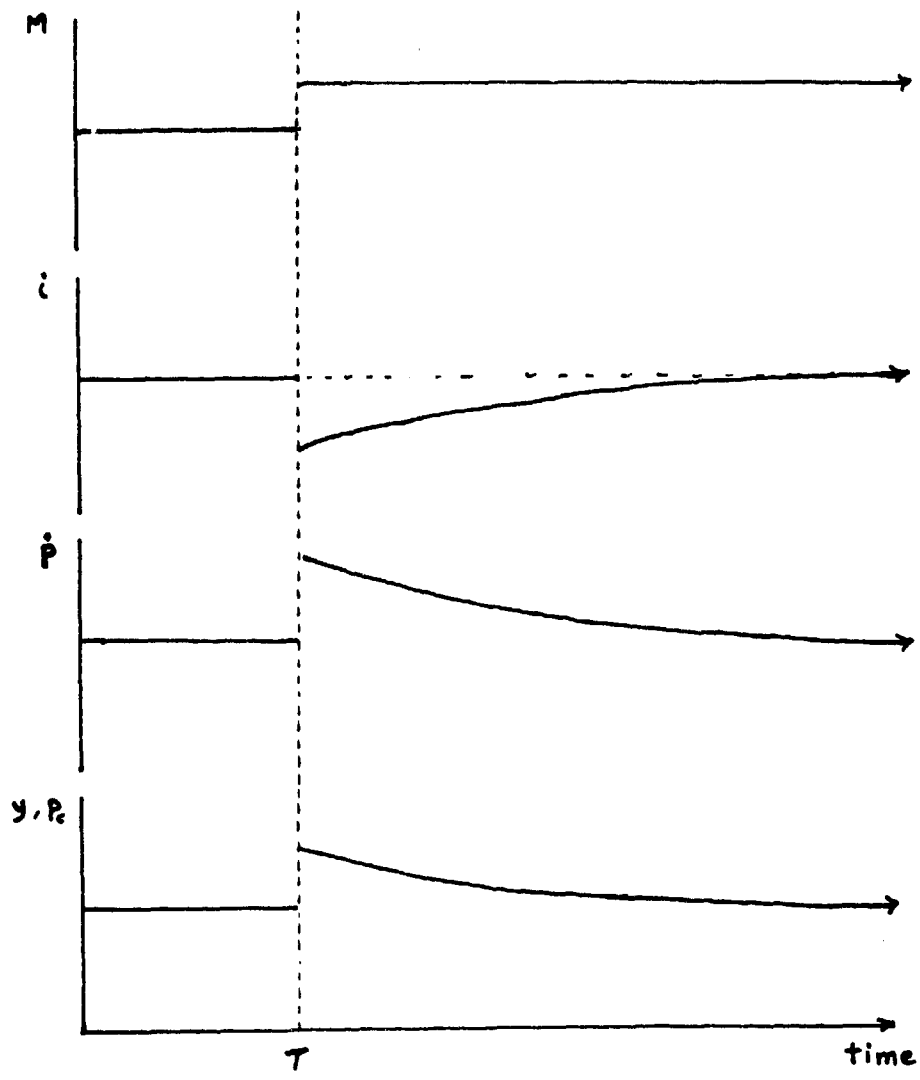


Figure 2. The time path of nominal interest rates, inflation and commodity prices in response to a permanent fiscal expansion in the OECD.

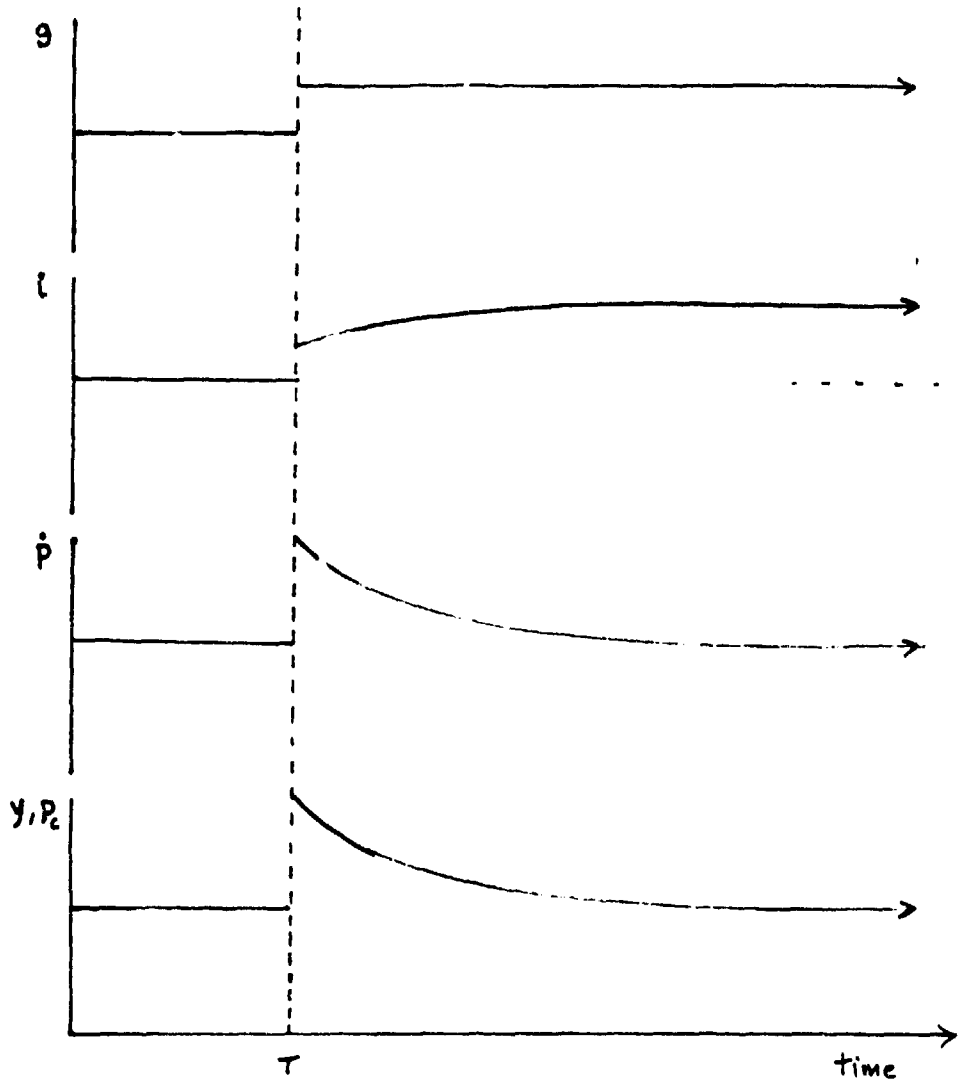


Figure 3. The time path of nominal interest rates, inflation and commodity prices in response to an oil price increase (or any adverse supply shock) in the OECD.

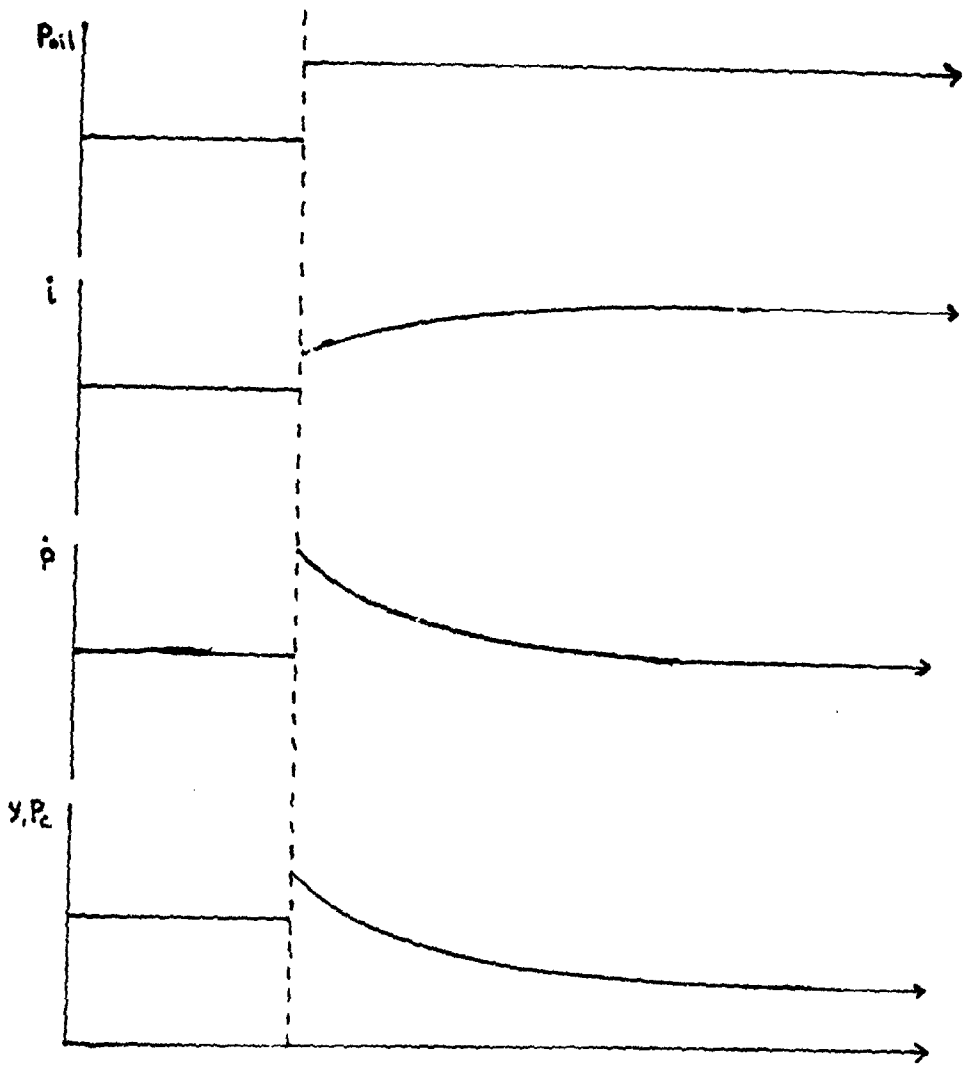


Figure 4. Conditional frequency distribution for inflation-indexed borrowing: $f(\Delta(\pi/i) \mid \Delta W_x < 0)$

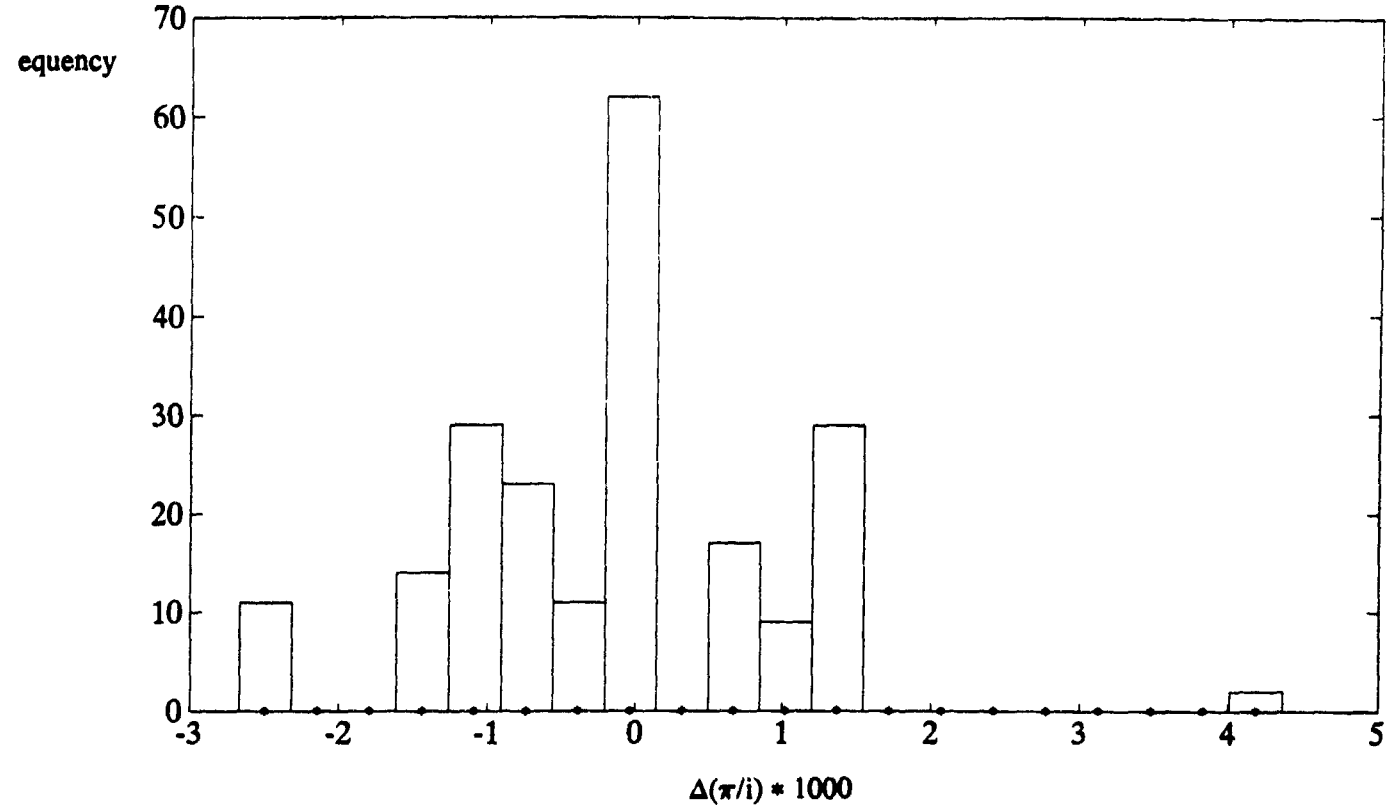
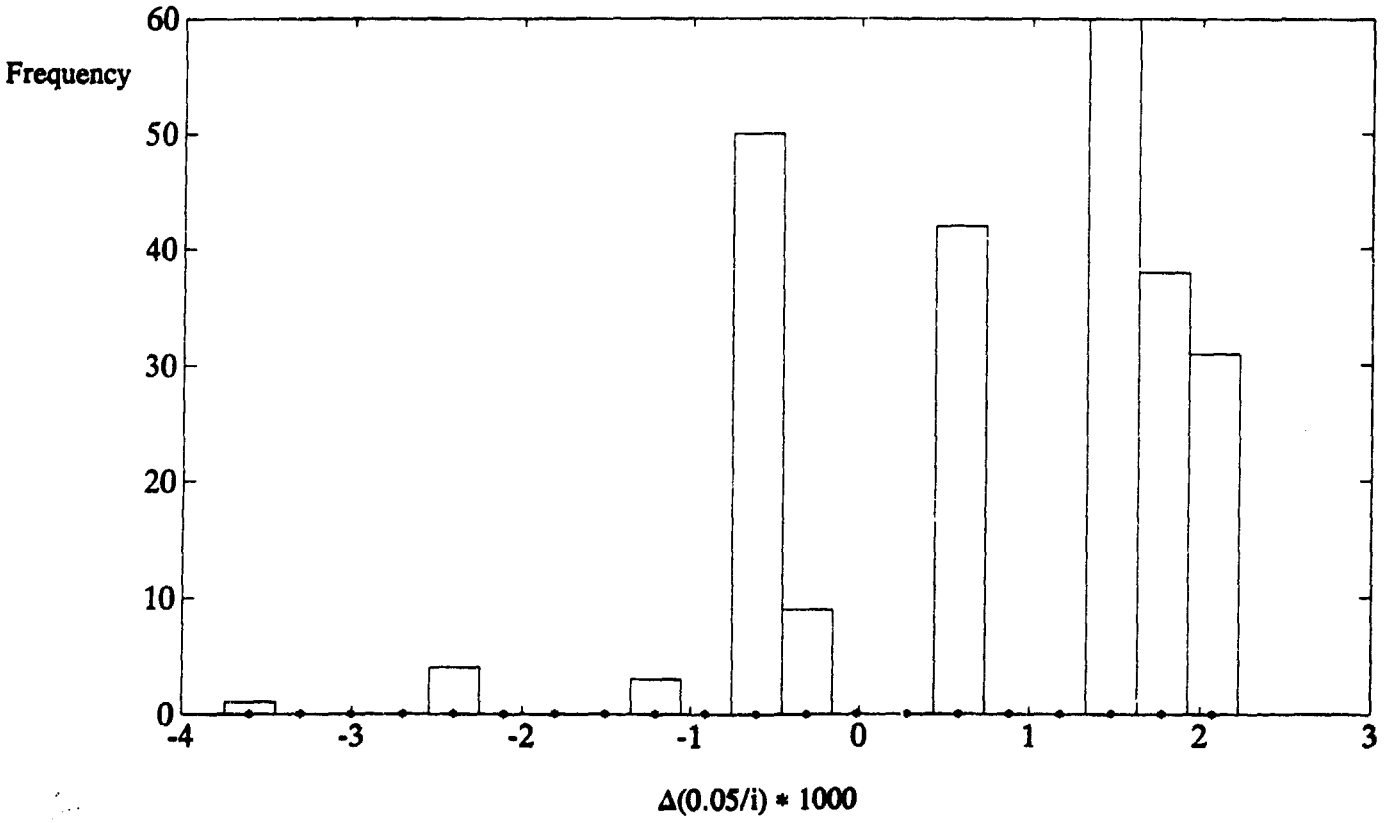


Figure 5. Conditional frequency distribution for fixed interest rate borrowing: $f(\Delta(0.05/i) \mid \Delta W_x < 0)$



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